EUROPEAN ATHLETICS

COACHING SUMMIT SERIES

Biomechanics and the Rules of Race Walking

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ENGLAND ATHLETICS

Biomechanics and the Rules of Race Walking

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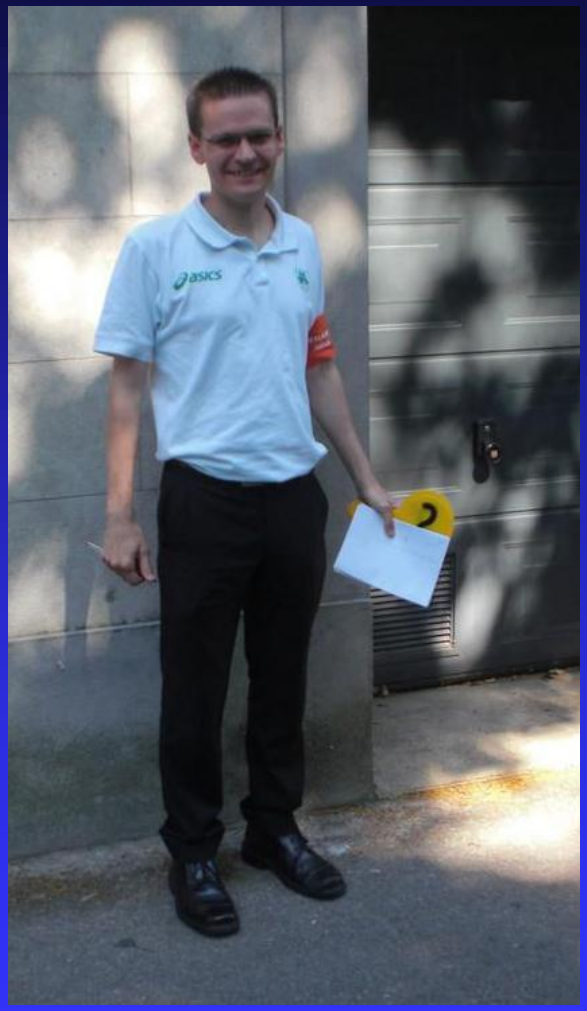
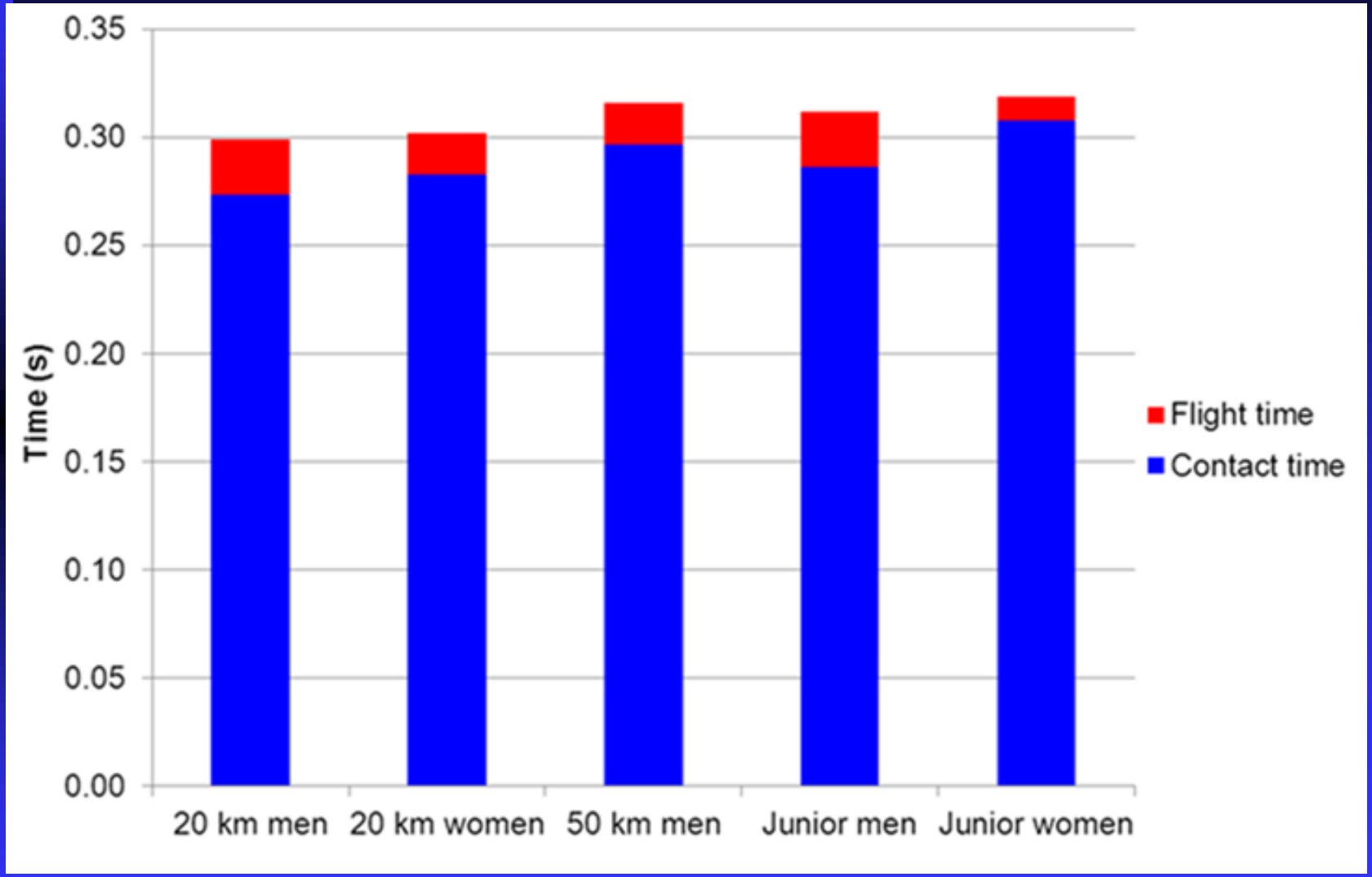
The rules and judging

- Judging is probably the most contentious part of race walking. This is partly because it is based on objective assessments made by individual judges.
- Disqualification in other events is not uncommon (seven male athletes DQed in 400 m heats at 2012 European Championships) but there is an obvious focus on the contact aspect of race walking.



Non-visible loss of contact



Sample of 90 senior competitors and 40 juniors

Would technology help?

High speed cameras appear to show lengthy flight times but these are often not visible with the human eyes or even with normal cameras.

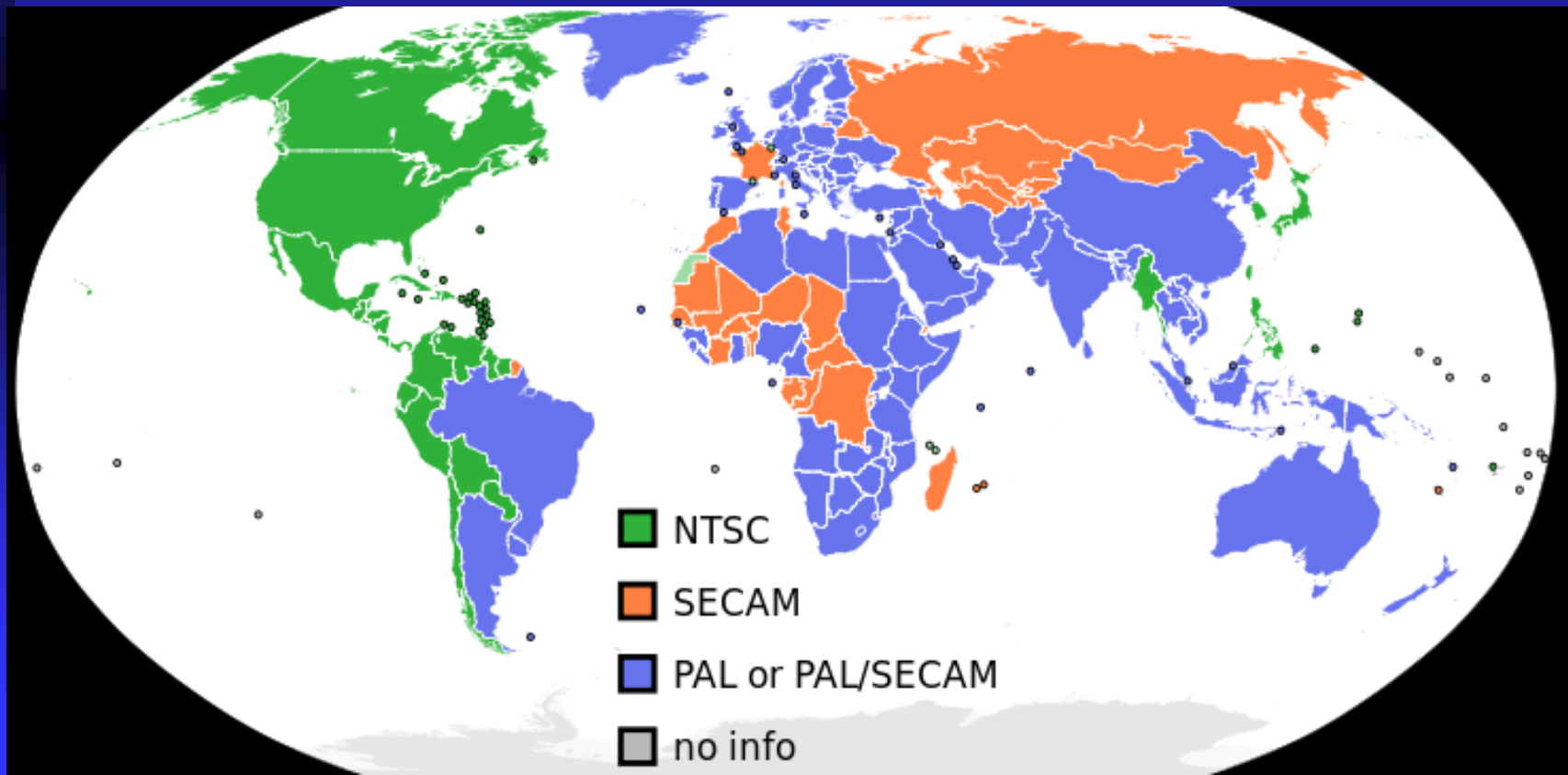
If cameras were to be used, there would need to be agreement on technical details like shutter speed, *f*-stop, analysis tools, expert operators…

25 frames per second

250 frames per second

Video cameras are not uniform

- PAL = 25 frames per second
- SECAM = 25 frames per second
- NTSC = 30 frames per second



In-shoe timing devices

Lapka (2011) recommended using “clever shoes” with in-built chips which would transmit loss of contact data to the DQ board with no judge input.

What are the problems with this suggestion?

The need for judge education

We need to be clear that ‘visible (to the human eye) loss of contact’ should not mean we second-guess based on other movements of the body.

Everyone’s gait is different and judging should not be a form of style appreciation as in gymnastics or diving.

Bent knees

- "...The advancing leg must be straightened (i.e. not bent at the knee) from the moment of first contact with the ground until the vertical upright position."

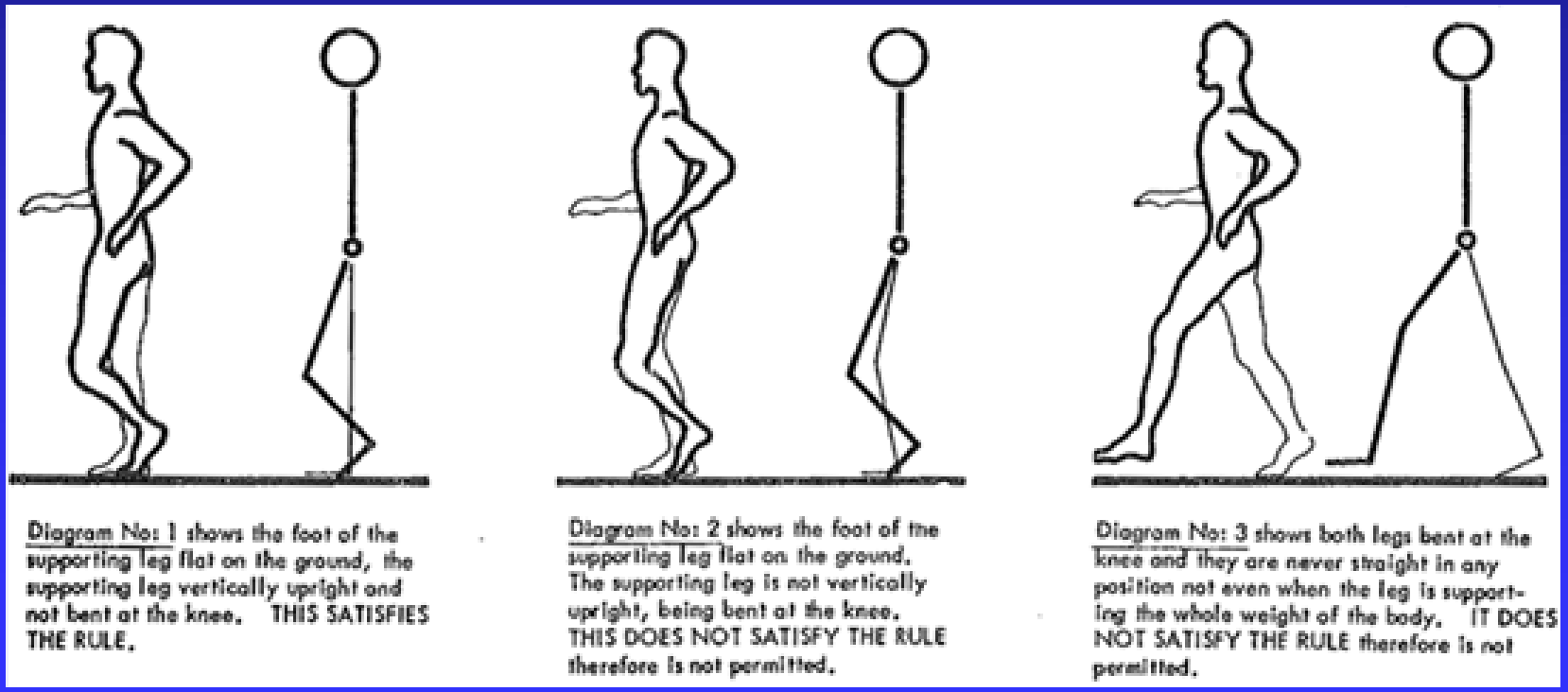


Diagram No: 1 shows the foot of the supporting leg flat on the ground, the supporting leg vertically upright and not bent at the knee. THIS SATISFIES THE RULE.

Diagram No: 2 shows the foot of the supporting leg flat on the ground. The supporting leg is not vertically upright, being bent at the knee. THIS DOES NOT SATISFY THE RULE therefore is not permitted.

Diagram No: 3 shows both legs bent at the knee and they are never straight in any position not even when the leg is supporting the whole weight of the body. IT DOES NOT SATISFY THE RULE therefore is not permitted.

IAAF, 1972

The need for judge education

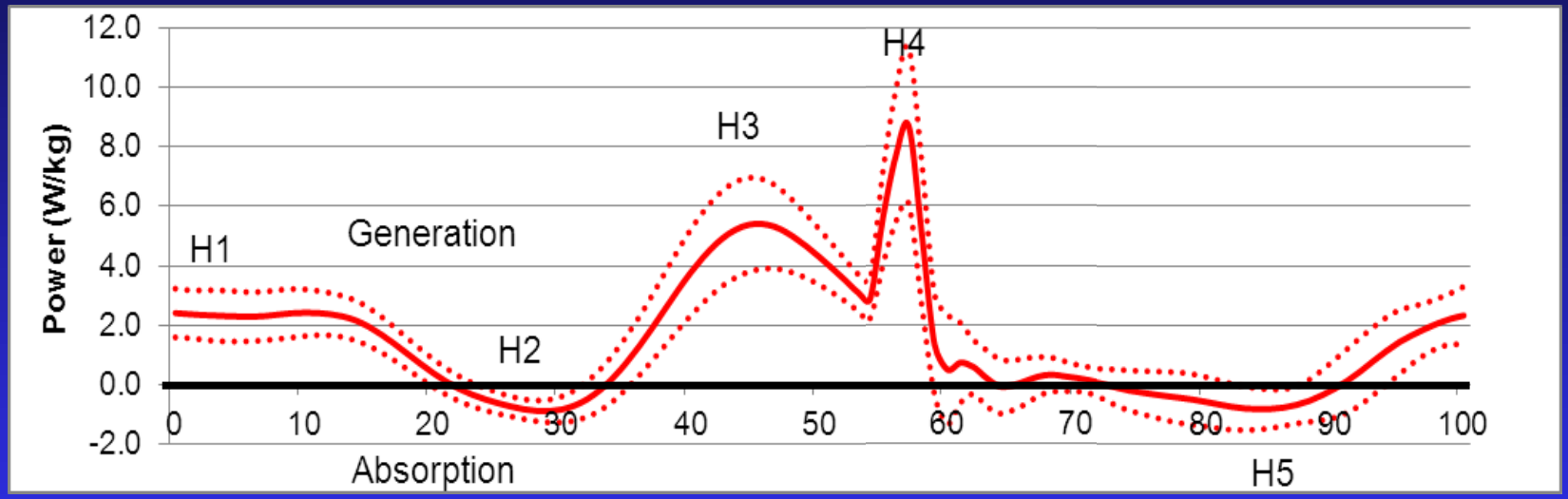
We need to be clear about the position we judge the knee from (i.e. side-on).

The need for judge education

We need to be clear on the meaning of ‘the advancing leg must be straightened (i.e. not bent at the knee)…’ and ‘…until the vertical upright position’.

Advantage of a bent knee

The peak power generated by the hip is correlated with lower knee angles at contact (r = –.53, p = .017).



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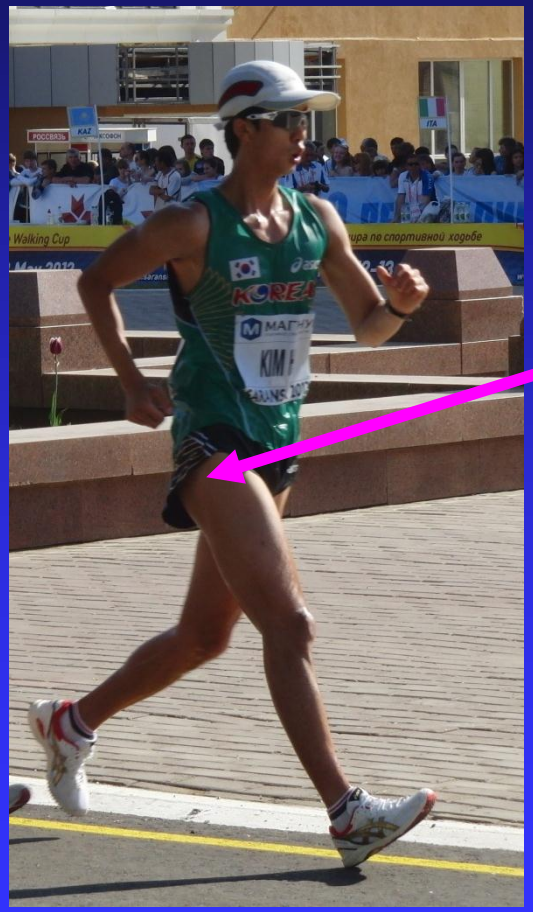
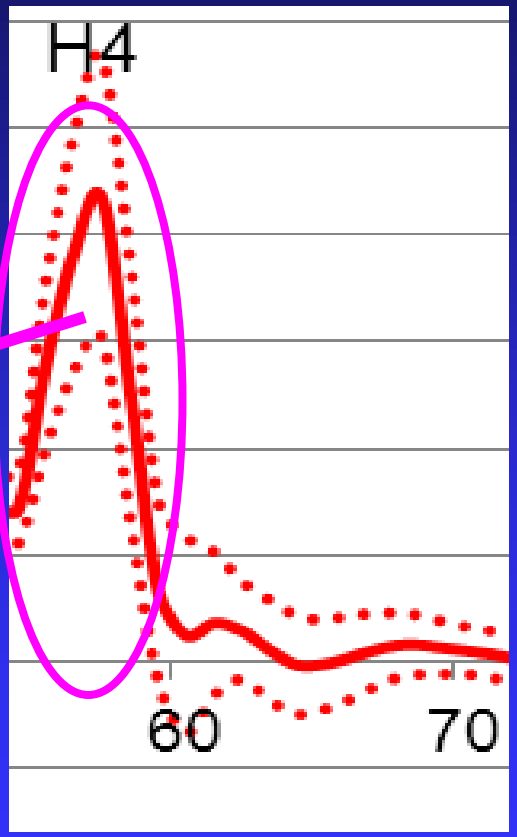
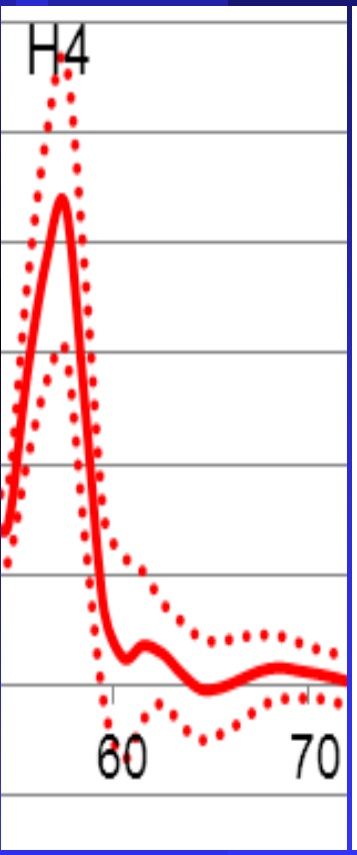


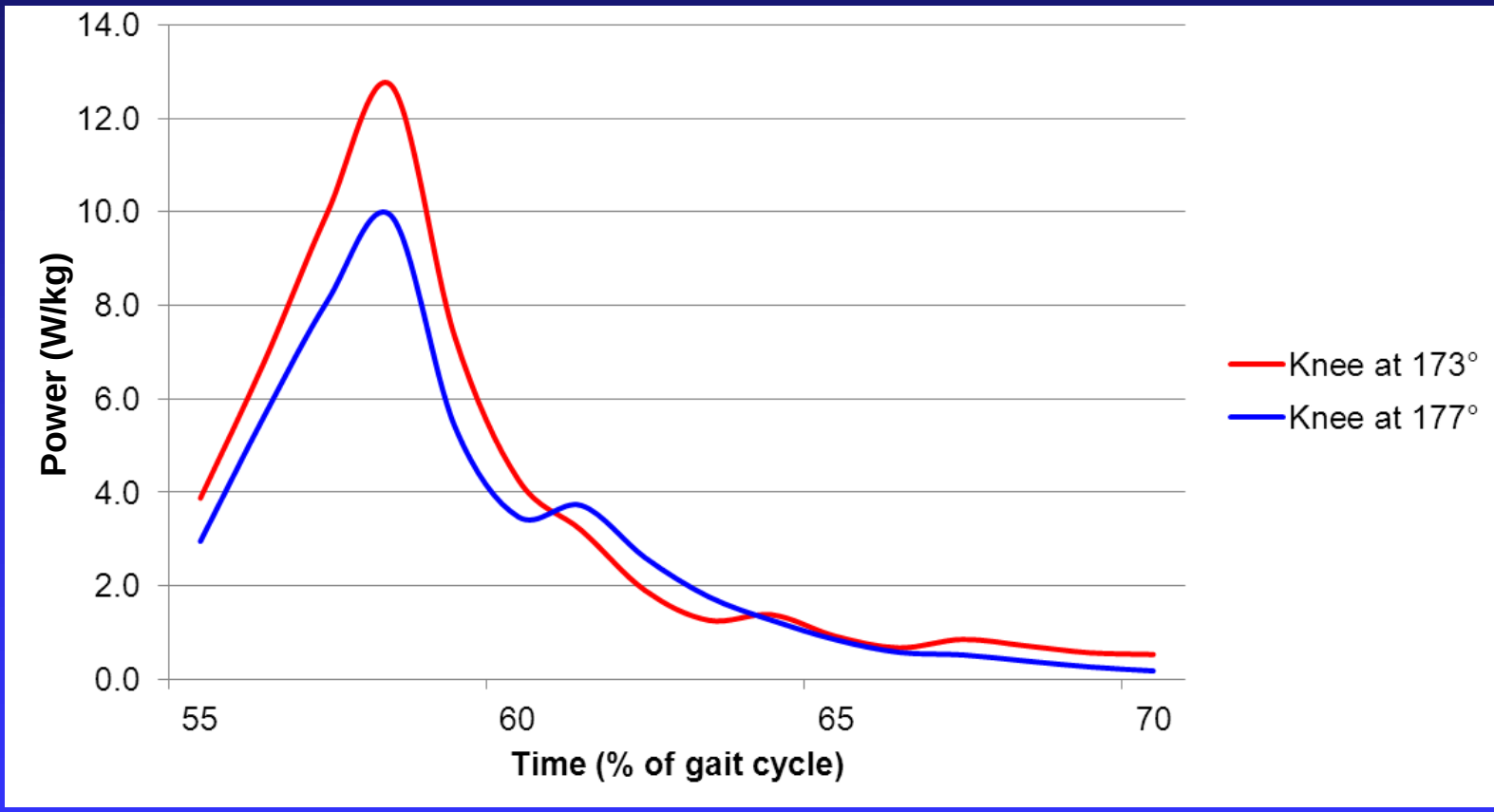


Bent knees may assist the walker in producing hip power.

Advantage of a bent knee

We have found very few athletes with bent knees in testing but power was greater when the knees were bent.





Senior man

Effects of the straightened knee

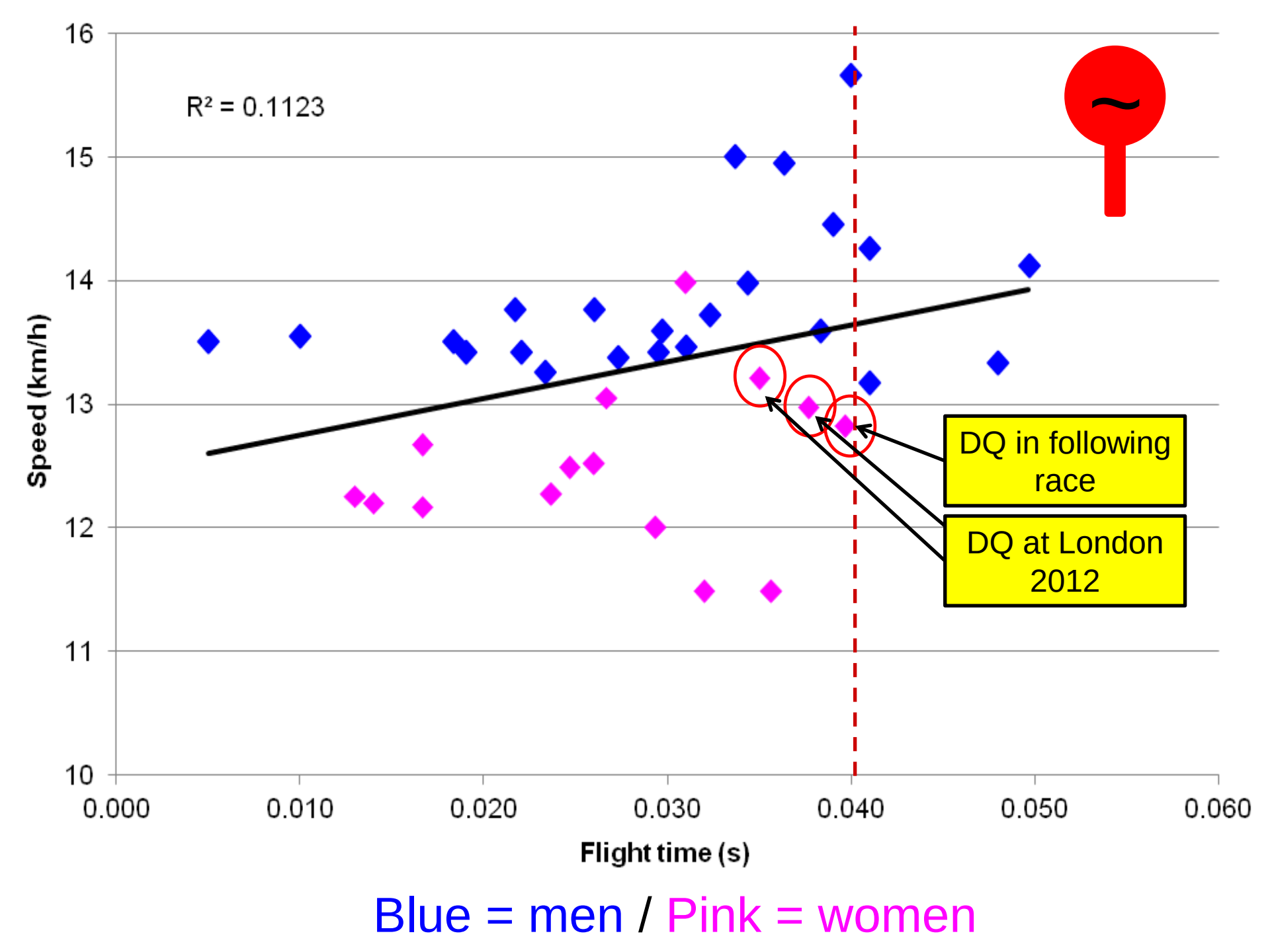
The rules of race walking mean that the stance knee is redundant in terms of producing forward motion. This results in three important outcomes:

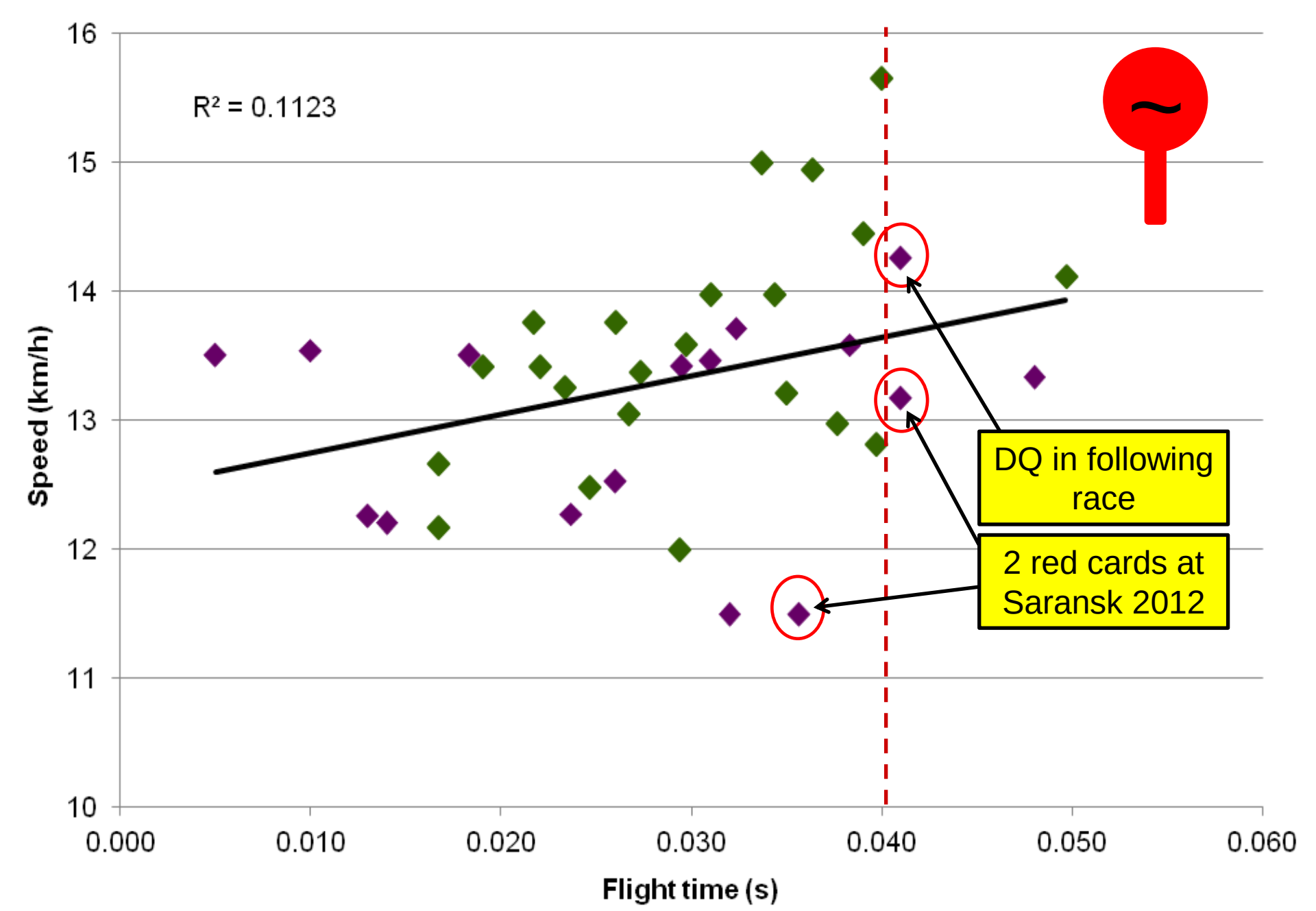
1. The hip extensor muscles (e.g. gluteus maximus) are crucial in preventing too much braking at contact.
2. The ankle plantarflexor muscles (e.g. gastrocnemius) are stretched by knee (hyper)extension – this may aid in terms of elastic energy when it comes to push-off.
3. The swing leg's rapid forward motion is what keeps the body moving forward around the stance leg (acting as a pivot).

Development of hip flexor power is important in driving the swing leg forward to counteract the restriction on the stance leg and is one of the key factors to success.

Measuring loss of contact

- As part of our research on ground reaction forces during race walking, we measured flight times in 38 elite junior and senior race walkers (23 men and 15 women).
- These athletes included 14 walkers who competed in either the Olympic Games or the World Championships (or both). One athlete won medals at both these championships.
- The athletes walked at close to race pace over two force plates which measured contact time and flight time. The plates recorded these times to 1/1000 of a second.


R² = 0.1123
Speed (km/h)
Flight time (s)
16
15
14
13
12
11
10
0.000
0.010
0.020
0.030
0.040
0.050
0.060
DQ in following race
DQ at London 2012
Blue = men / Pink = women

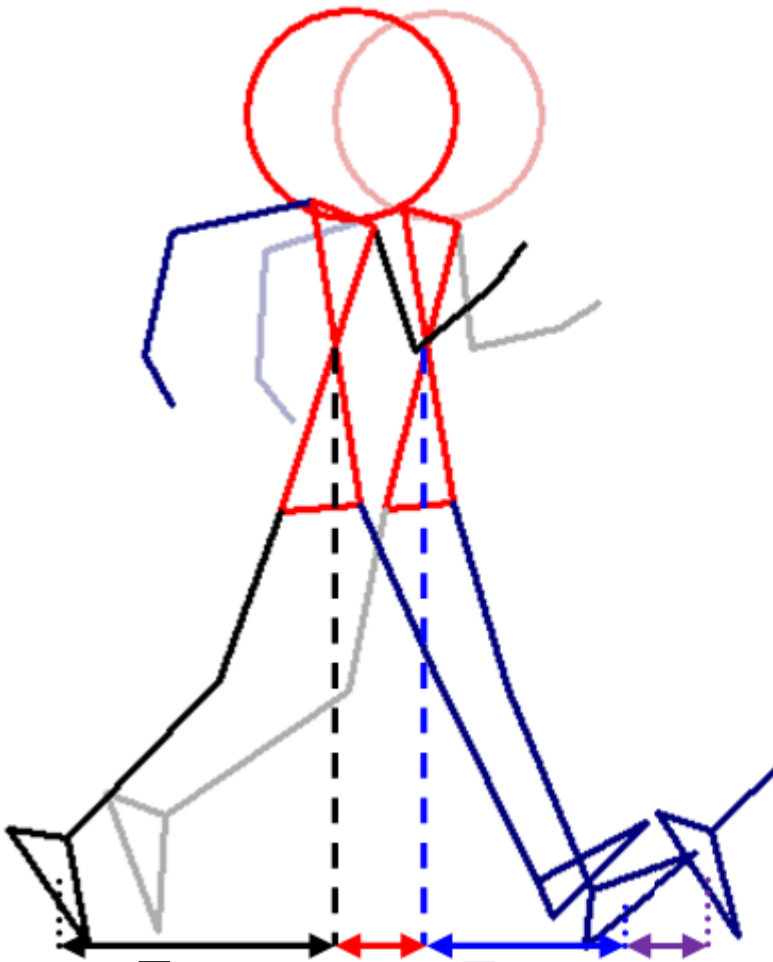


Green = seniors / Purple = juniors

Force plate measurements

On average, the top 10 senior and top 10 junior athletes would have been 0.29 km/h slower with no flight time. The men would have larger reductions in speed (0.39 km/h) than women (0.19 km/h). However, some athletes would be faster if they had no flight time! This is because the distance they gain through the air is cancelled out by a lower cadence. This does not mean however that they are not gaining an advantage during flight – their muscles have more time to recover between gait cycles.

The components of step length



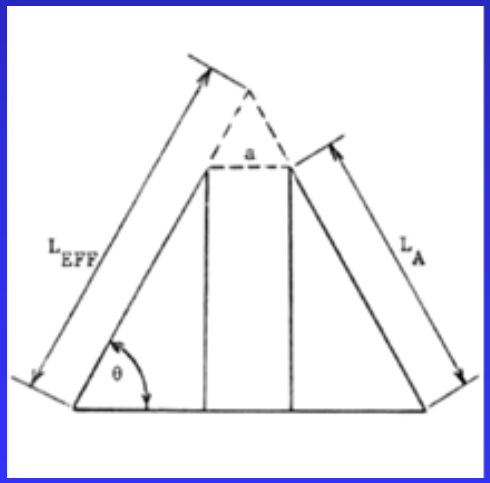
The shoe contributes about 20 cm of step length!

Men's ratio – 41:10:32:17

Women's ratio – 41:9:32:18

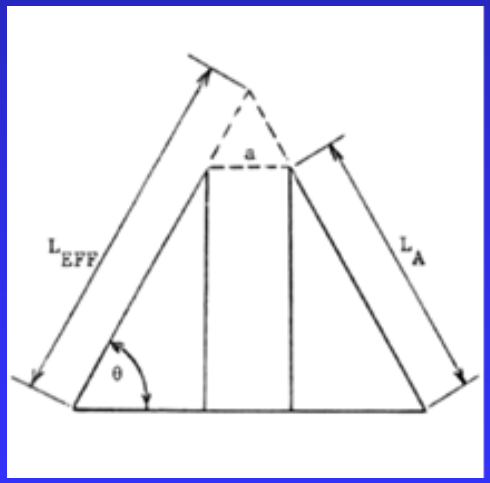
Maximising step length without visible loss of contact

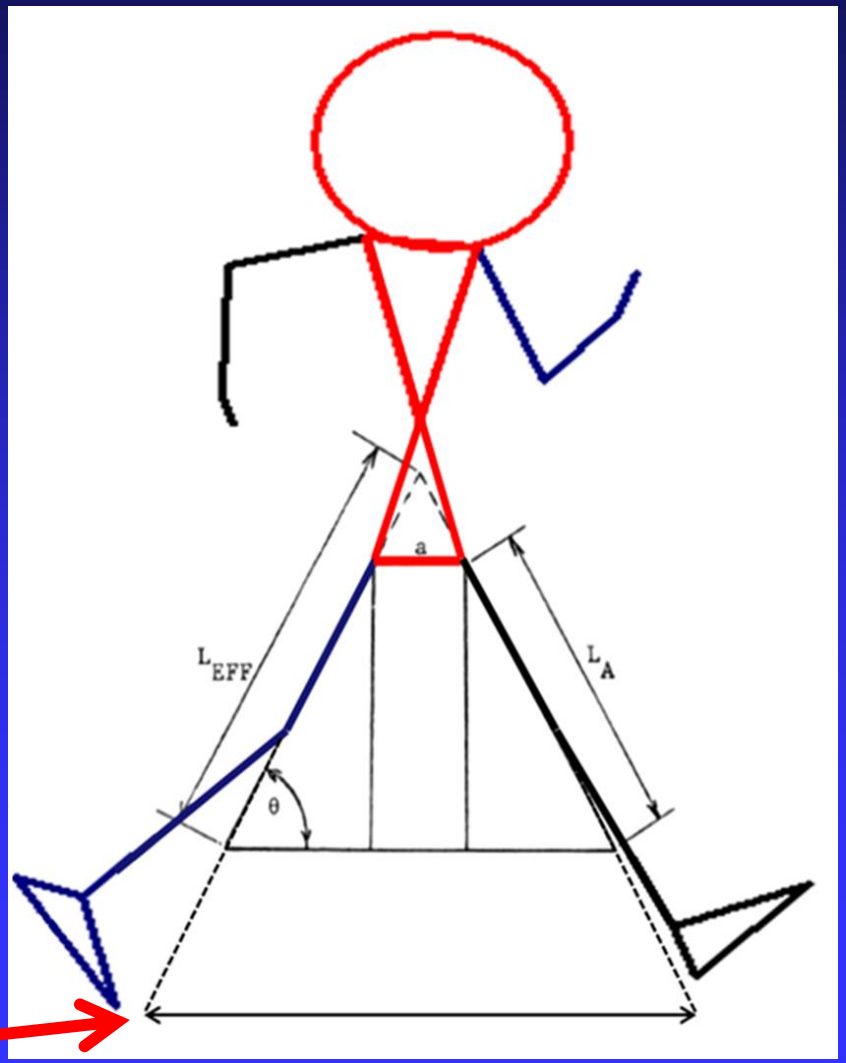
Trowbridge (1981) believed that step length was limited by the actual length of the leg but could be increased with pelvic rotation (which created a longer ‘effective leg length’).



L_A = Actual leg length
L_{EFF} = Effective leg length
a = Increased distance between hip joints due to pelvic rotation
Θ = Angle of the leg to the horizontal

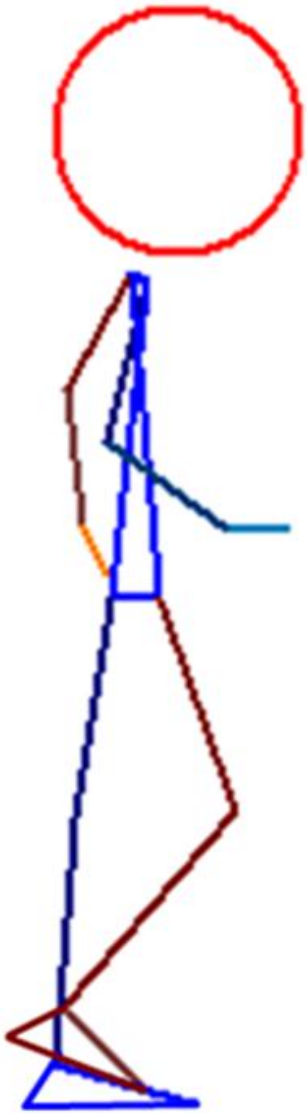
Maximising step length without visible loss of contact





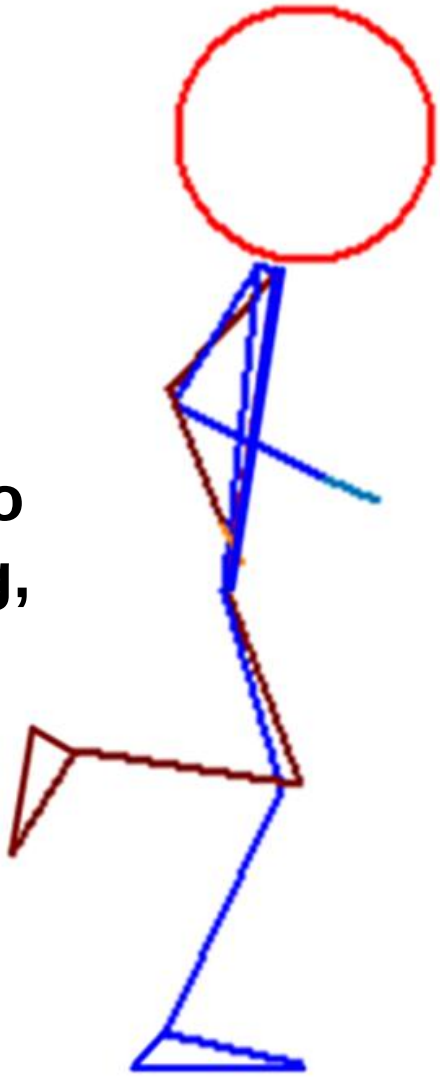
Extra distance gained →

Race walking is not running



Race walking

In race walking, the knee *flexes* from midstance to toe-off; in running, it *extends*.

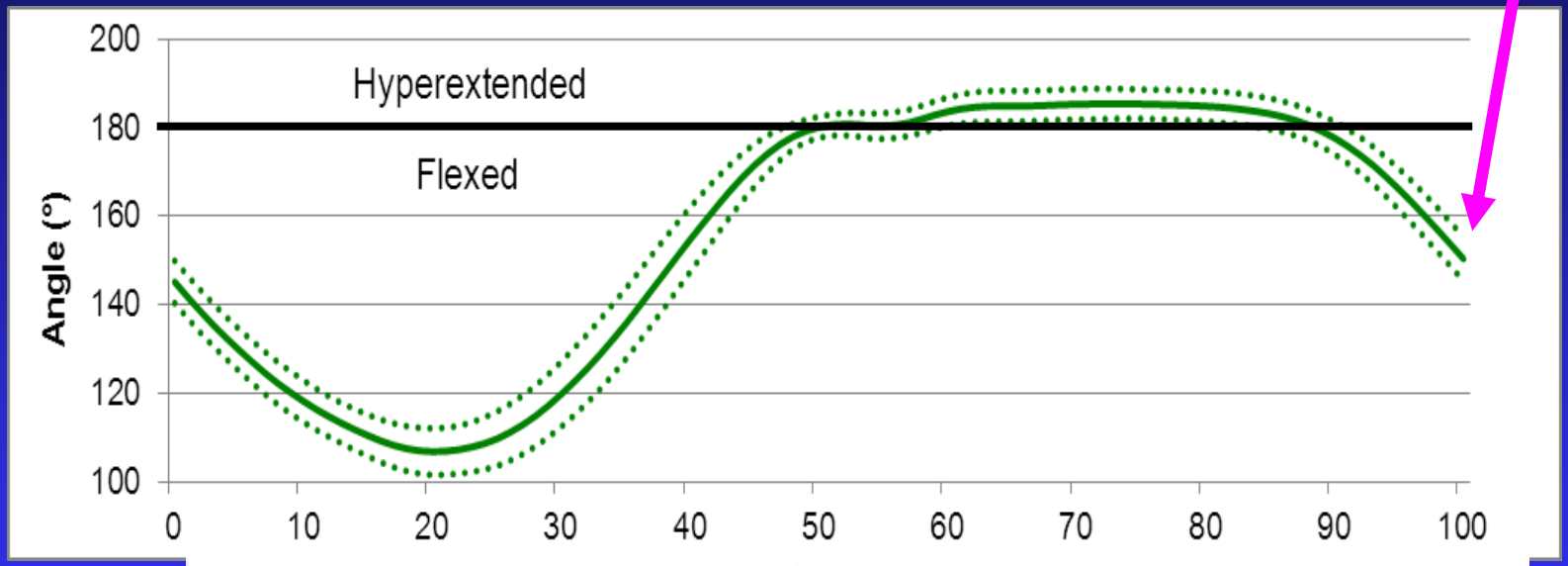


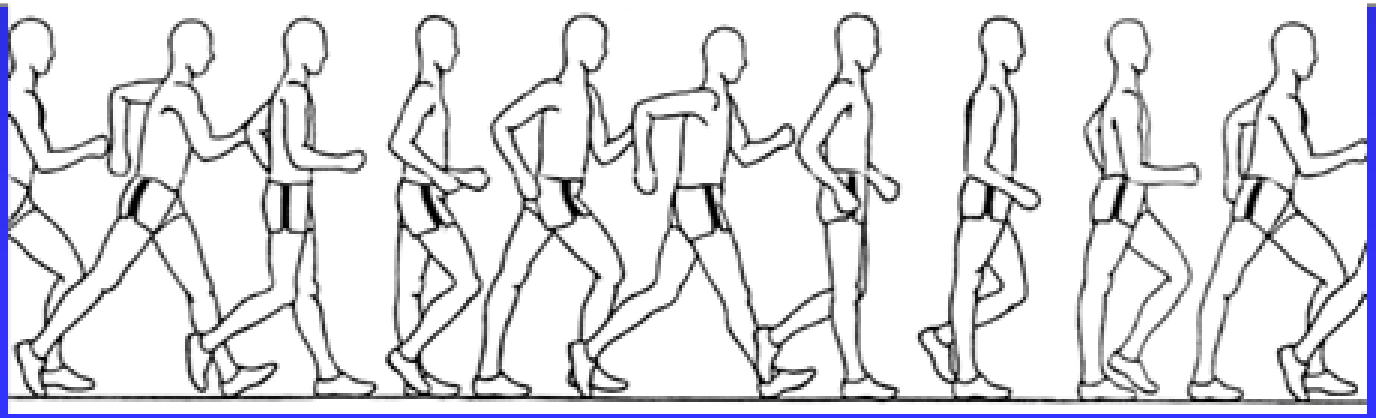
Distance running

The knee at toe-off

The right amount of knee flexion

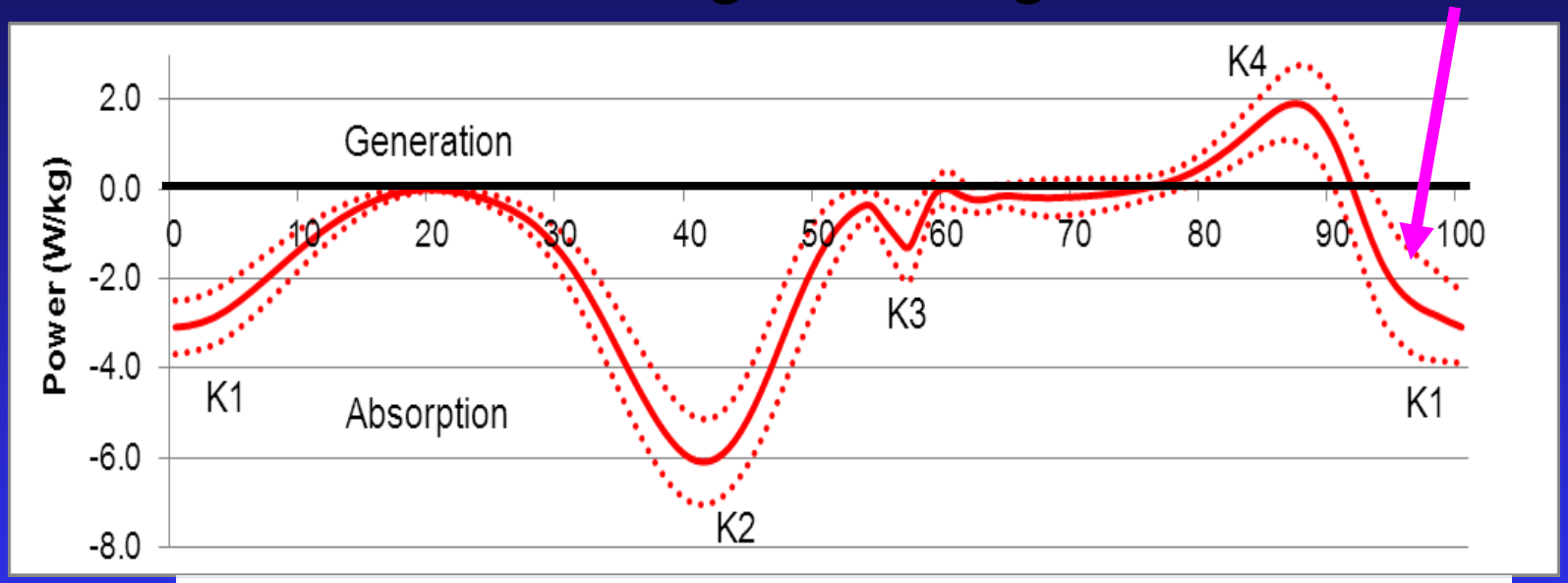
You can see in the graph below that the knee flexes during the last 10% of stance to about 150°

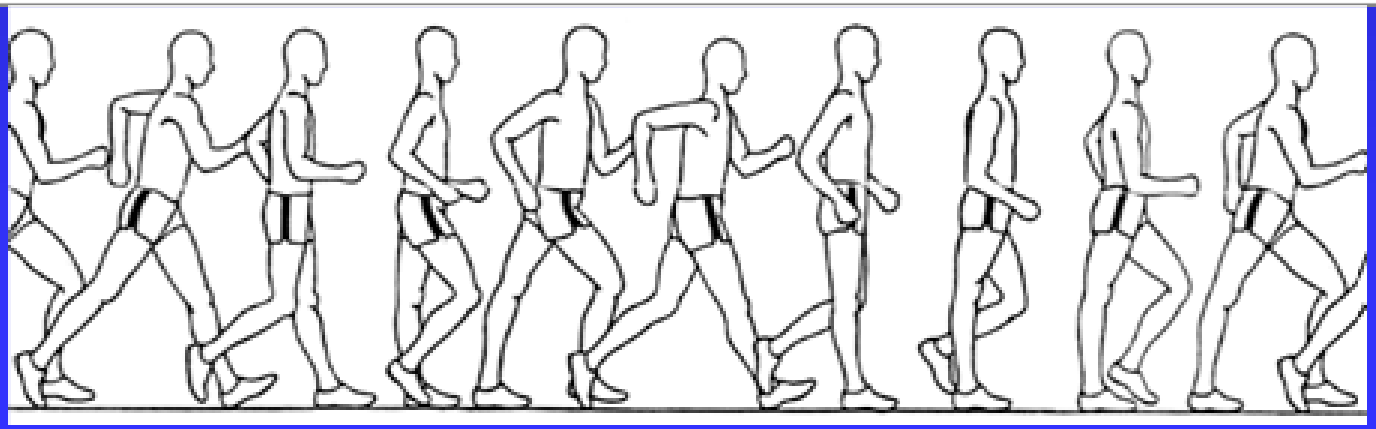


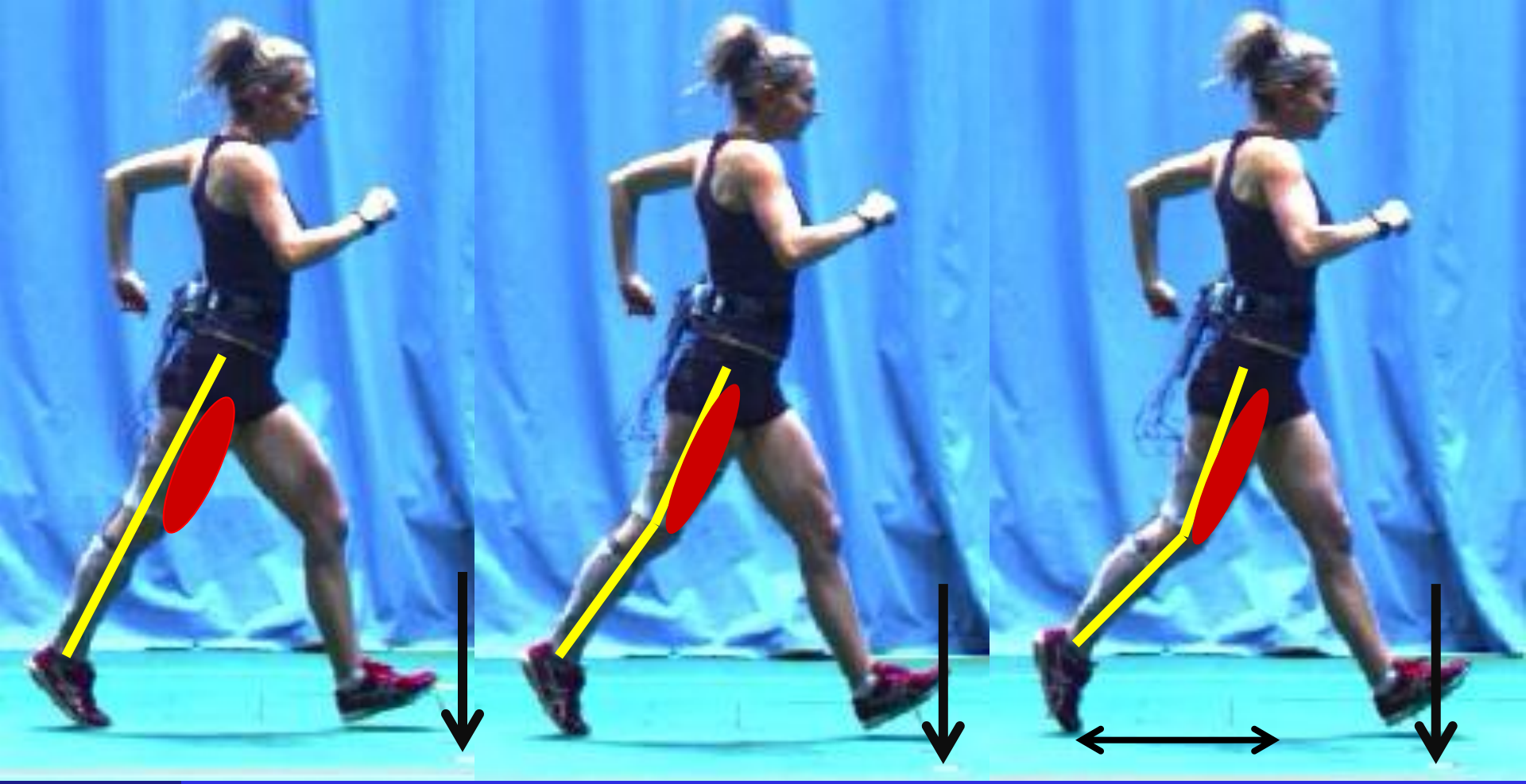


Restraint of knee flexion

The knee is restrained from flexing too much so that it is easier to straighten it again at contact.





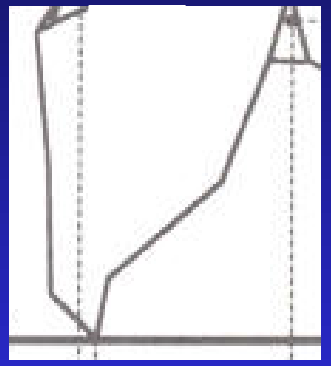


The knee movement late in stance allows the foot behind distance to be larger, causes a stretch of the knee extensors which help restrain flexion during early swing, and gives more time for the athlete to increase foot ahead.

The knee in late stance

The knee's motion from full extension (or hyperextension) to flexion is not normal in walking or running. However, getting this aspect of technique correct is important as it:

1) Increases step length
2) Lowers the centre of mass
3) Keeps the feet low to the ground during the swing phase



In effect, the walker moves faster but with less chance of visible loss of contact. This motion of the leg also stretches the hip flexors assisting the forward drive of the thigh during swing.

The knee in late stance

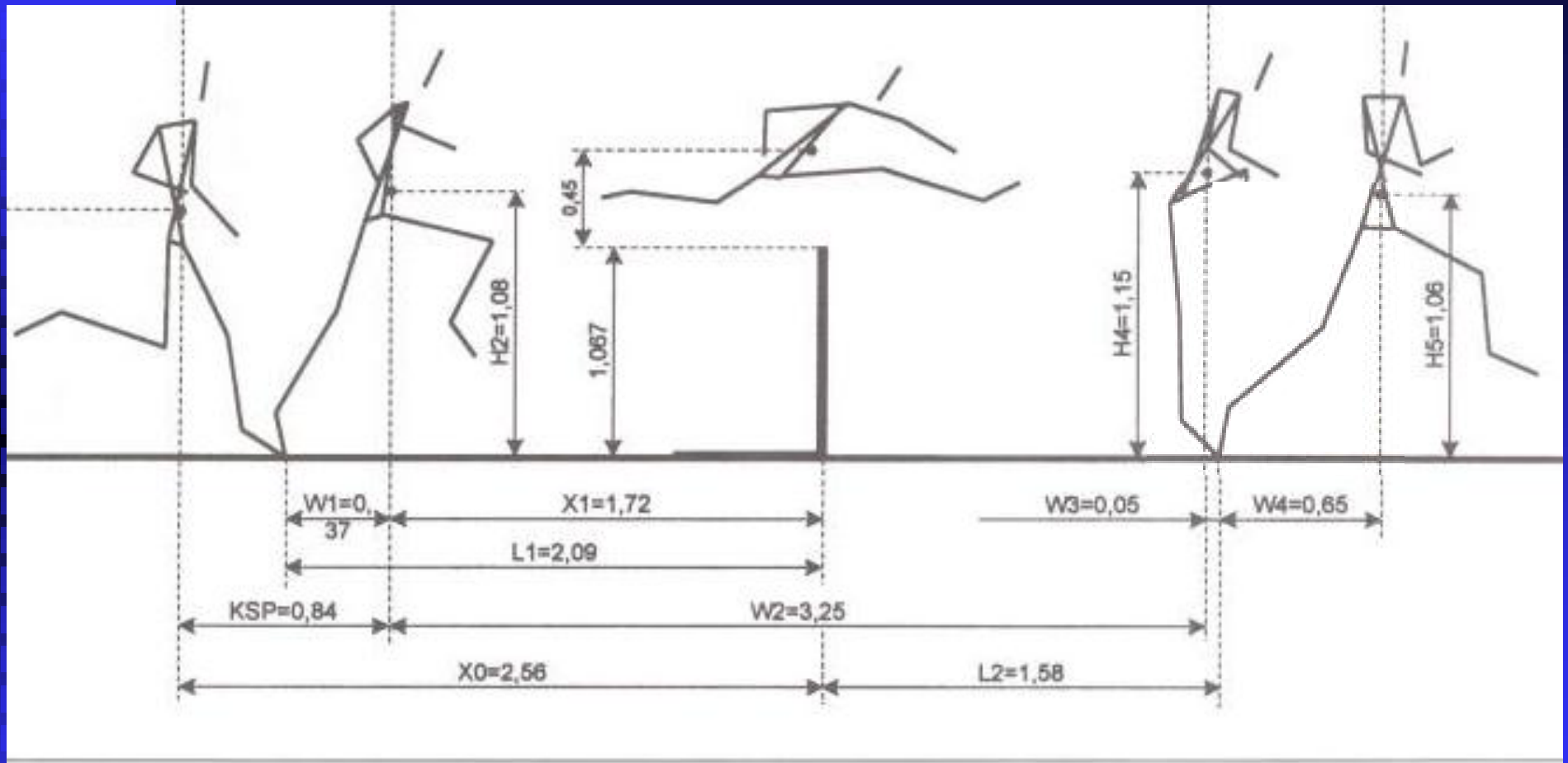


Figure 4: Hurdle clearance (Colin Jackson - 13.47s)

Can you clear ten 1.06 m hurdles efficiently at half-speed?
Can you race walk efficiently at half-speed?

The need for speed

- With regard to sprint running training, Harrison (2010) cautioned against the use of particular popular training drills which did not replicate true sprinting mechanics (e.g. heel flicks).
- At elite level, race walking is an elastic activity which requires speed to be effective. Coaches should be cautious about adopting drills at a slow speed in trying to emphasise movements which cannot be replicated once the athlete moves at a speed closer to race pace.
- Such low level drills may however be useful for beginners in explaining technical points.

Summary

- Infringement of either aspect of the race walking rule gives an advantage to the athlete.
- The requirement for straightening the knee increases the importance of the gluteal and hamstring muscles in maintaining speed.
- The unusual knee movements in race walking need to be delicately balanced in terms of optimising performance needs (e.g. step length) while avoiding visible loss of contact.
- Elite race walking (like other elite athletic events) requires muscle elasticity and training needs to reflect this.

Thank you for your attention!

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- Trowbridge, E. A. (1981) Walking or running - when does lifting occur? *Athletics Coach*, 15(1), pp.2-6.